

Development of a Comprehensive Methodology for Assessing the Quality of Solar Photovoltaic Systems

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WPI

[< ENERGY](#)**Carnegie big**

The Advertiser

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Opinion | Opinion

Is there opportunity in current gas 'crisis'?

By Robert Gottlieb

ADELAIDE 16-21°C

ROBERT GOTTLIEBSEN

Gottlieb: Energy crisis risk is criminal

**cent, eight years ahead of
schedule**

The Little Black Book of Billionaire Secrets

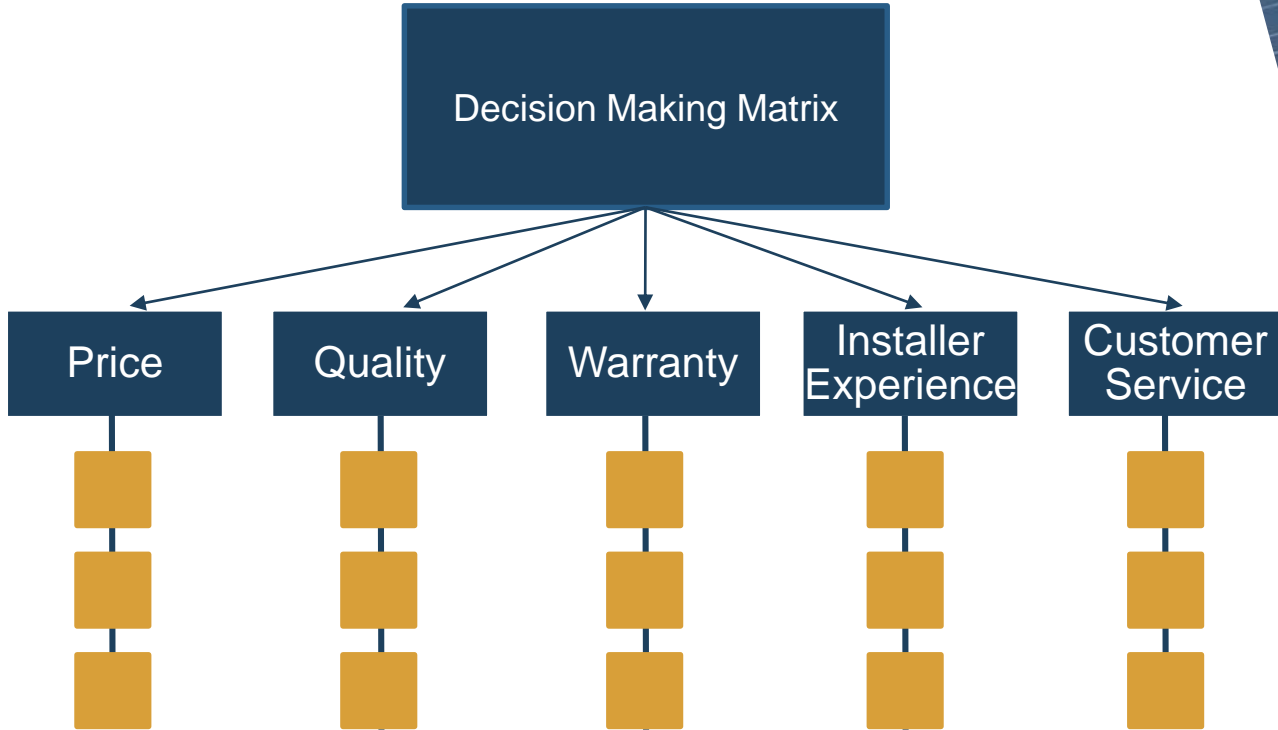
mise To Fix South Australia's

ROBERT GOTTLIEBSEN**Energy crisis: time to invest in emergency
power**

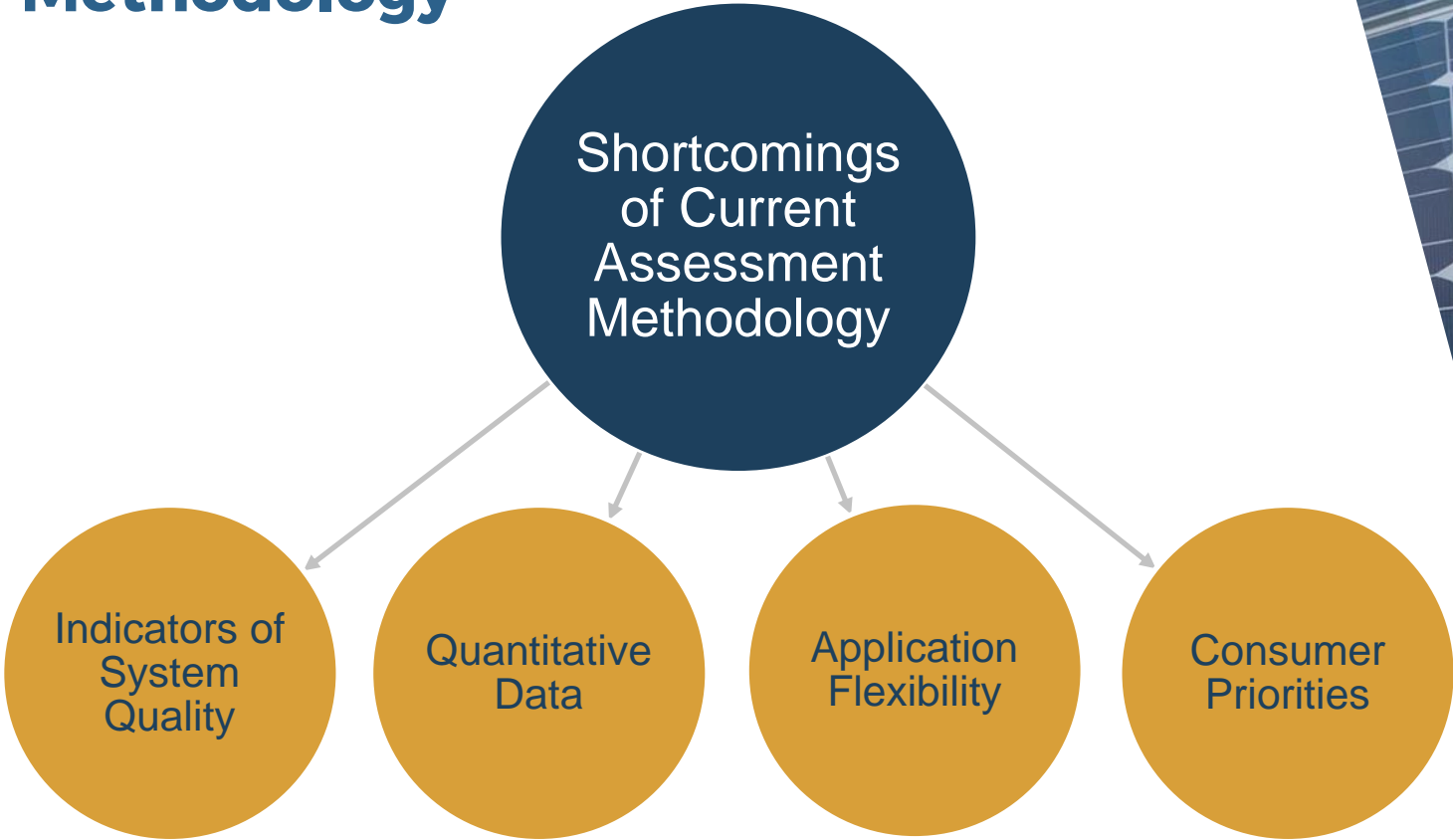
Importance of Assessing System **Quality**



Current Assessment Methodology



Current Assessment Methodology



Project Objectives



1. Researched factors affecting solar photovoltaic system quality



2. Determined metrics which indicate quality of solar PV systems



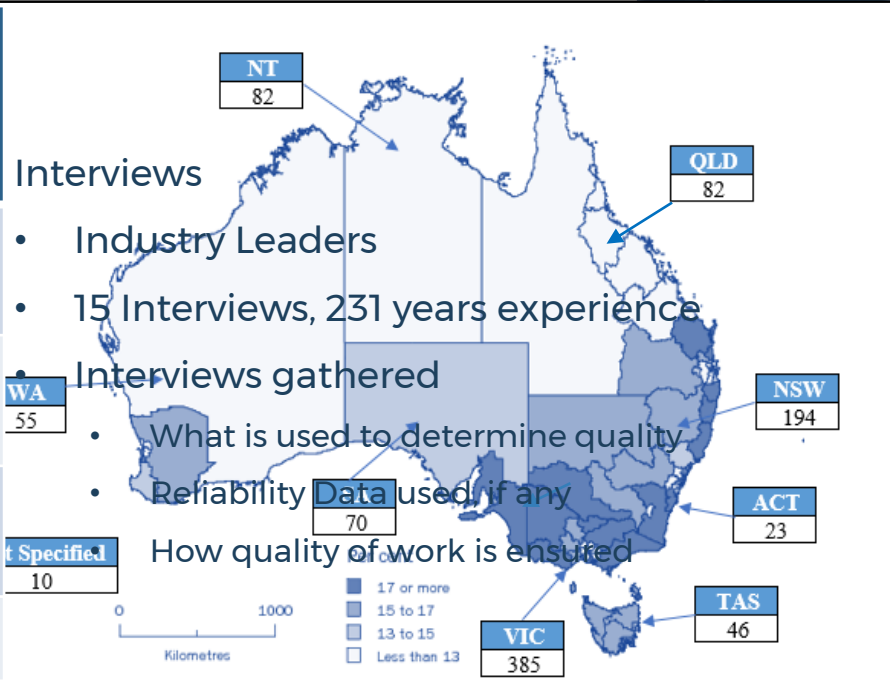
3. Developed an understanding of consumer priorities



4. Designed a more comprehensive decision making matrix

Overview of Survey and Interviews

Industry Leader Category	Interviews Conducted	Total Years of Experience in the Solar Industry
Retailers & Installers	10	160
Researchers/ Experts	2	32
Solar Manufacturers	3	39
TOTAL	15	231

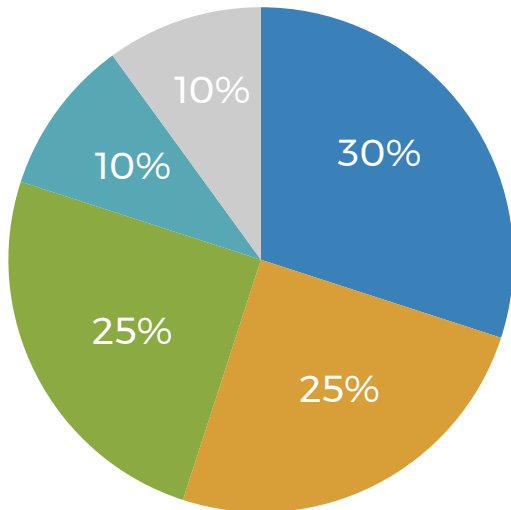


Consumer Priorities

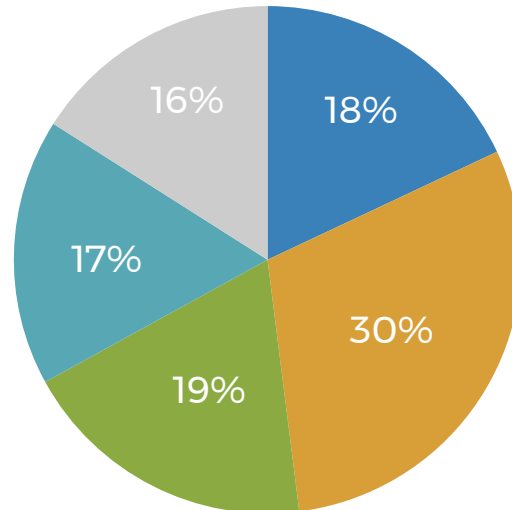


Matrix Tabular Weightings

Original Weightings



Revised Weightings



Quality Warranty Price Installer Experience Customer Service

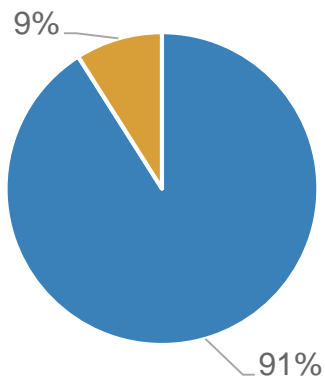
Matrix Tab: Price

\$/W Calculated from Array Capacity

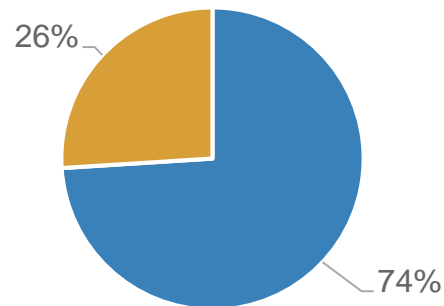
Score	Array Capacity	Inverter Capacity	Price	Metric
	kW	kW	\$	\$/W
10.0	4.00	4.00	\$3,699	\$0.92
7.6	4.00	4.00	\$5,896	\$1.47
7.4	4.00	4.00	\$5,980	\$1.50
4.7	3.24	3.24	\$6,300	\$1.94
9.6	4.00	4.00	\$4,590	\$1.15
6.7	3.68	3.68	\$5,967	\$1.62
8.7	4.00	4.00	\$5,190	\$1.30

Importance of **Warranty**

Time Frame of Installation Failures



Time Frame of Inverter Failures



- Failures within 3 years of install
- Failures after 3 years since install

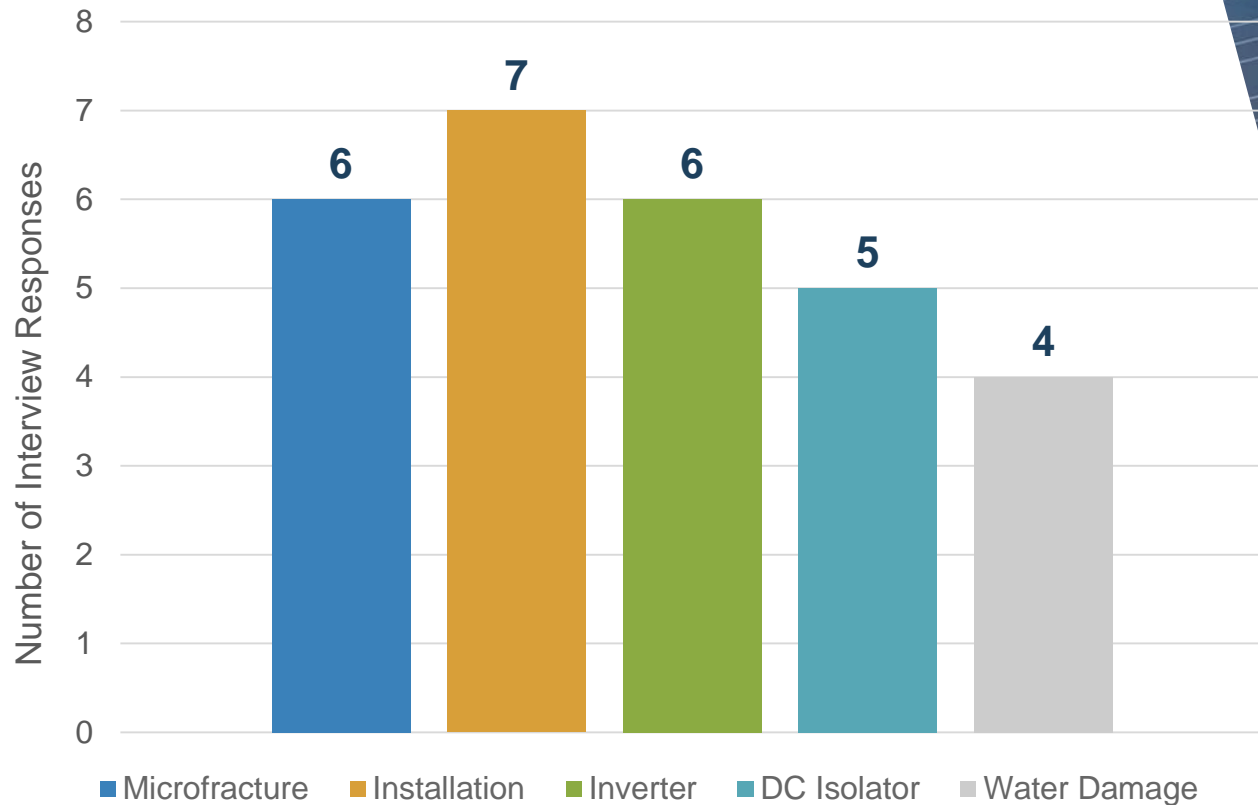


Matrix Tab: Warranty

Now Accounts for both Warranties

Total	Installation		Inverter		Panels			
out of 10	Years	Score (Out of 10)	Product (Years)	Score (Out of 10)	Product (Years)	Performance (Years)	Performance (% Level)	Score (Out of 10)
5.3	5	5.0	5	5.0	12	25	80	6.0
5.3	5	5.0	5	5.0	12	25	80	6.0
8.3	5	5.0	10	10.0	25	25	85	10.0
8.1	5	5.0	10	10.0	25	25	80	9.4
6.8	5	5.0	10	10.0	10	25	80	5.4

Common Modes of System Failure



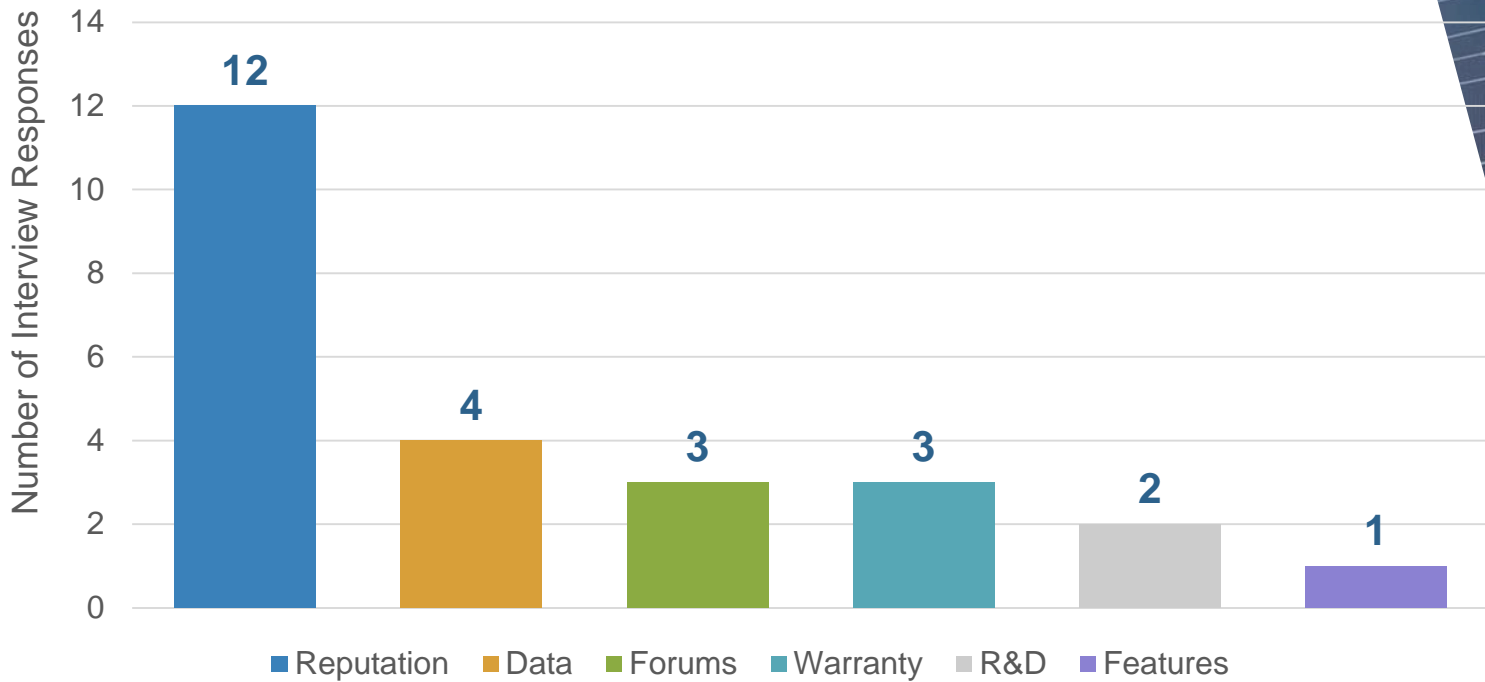
Matrix Tabs: Experience and Customer Service

CEC Accreditation

Shipping Protocol

Total	CEC Accredited (Yes or No)		Number of installs (either number or capacity)		Years experience of company	Use in-house installers (Yes, No, or Sometimes)	Positive customer feedback (out of 5)	Shipping Practices (out of 5)
	Retailer	Installers	Amount	MW p.a.				
out of 10								
4.1	Yes	Yes	400		7	No	1	3
4.1	Yes	Yes	400		7	No	1	3
8.8	Yes	Yes	600		7	Yes	5	3
8.8	Yes	Yes	600		7	Yes	5	3
5.1	No	Yes	1000		3	No	3	3

Company Location and Reputation



Matrix Tab: Quality

Additional Performance Metrics

Material Properties

Reputation

Total	Panel														
	Brand, Model	Performance					Reliability						Company Reputation (out of 10)	Reputation Notes	Score (out of 10)
		Efficiency	Temp Coefficient	PTC Ratio (Model)	Yield / Perform Ratio (Brand)	Score (out of 10)	Junction Box Protection IP__	Glass Type							
Out of 10							Tempered/ Toughed	High Transmit	Anti-Reflection Coating	Low Iron					
7.1	Jinko Solar Eagle 60P JKM280M-60	15.6%	-0.40%	91.86%	93.90%	7.7	67	Yes	Yes	Yes	Yes	7.5	A good midrange panel. Fairly new so not much information on failure rates.	8.8	
3.7	Dortmund Energy DM-60	15.9%	-0.42%			2.4						4	New panel on the Australian market. Very limited information available. No failure notes evident online.	1.9	

Module Assessment

Matrix Tab: Quality

Additional Performance Metrics

Certifications and Ratings

Reputation

Inverter													
Brand, Model	Performance						Reliability						
	Efficiency	String or Micro	Number of PPT Strings	Max DC Input			Score (out of 10)	Protection Class IP_	Operating Temperature		Company Reputation (out of 10)	Reputation Notes	Score (out of 10)
				Power (W)	Voltage (V)	Current (A)			Min (°C)	Max (°C)			
SMA Sunnyboy	96.4%	String	2	4200	750	15	6.5	65	-25	60	7	A good midrange inverter. Minimal reports of failures	5.6
Zeversolar Zevelution	96.5%	String	2	4650	600	11	6.3	65	-25	60	4	High failure rate reported. Very frequent, negative warranty/replacement experiences reported.	4.1

Inverter Assessment

Importance of Assessing System Design

Module Selection

- Monocrystalline
- Polycrystalline
- Thin-Film

Environmental Factors

- Solar Irradiance
- Temperature
- Rainfall

Inverter Selection

- String Inverters
 - Power Optimizers
- Micro Inverters

System Ratio

Oversize
Vs.
Undersize

Matrix Tab: **Application Parameters**

	Enter Values
Average Global Horizontal Irradiance (kW/m ²):	1600.0
Average High Temperature in Summer (°C):	26.0
Average Low Temperature in Winter (°C):	6.0
Average Annual Rainfall (mL):	64.8
Within 25 km from Seashore (Yes or No):	Yes
High Cost Constraints (Yes or No):	No
Rooftop Space Constraints (Yes or No):	No
Rooftops Affected by Shading (Yes or No):	No
Inverter Preference (String, Micro, None):	None
Max Inverter to Array Capacity Ratio:	0.75

Supplementary Deliverables

Tender Request Form

ATA

Tender Request Form

Solar PV Submission Document

Instructions:
Please complete the pages for your submission and submit with your Request for Quotation.

PV Scenario 1 [System Size Option 1](#)

Contents **System Size Option 1**

Product Registries

Material Data								
Brand (make etc)	Cell Type	Size in mm (L x W x T)	Weight (kg)	Cell Number	Glass Type	Glass Thickness (mm)	Frame Type	Junction Box Protection Class...
AID AC Solar Warehouse ph 0300 55 44 57 info@acsolwarehouse.com www.acsolwarehouse.com	Polycrystalline	1542 x 992 x 40	19	60	Highly transparent solar glass (hardened)	3.2 mm	Anodized Aluminium Alloy	IP67
		1555 x 992 x 40	22.5 (21.7)	72	Highly transparent solar glass (tempered)	3.2 mm	Anodized Aluminium Alloy	IP67
	Monocrystalline	1533 x 1546 x 46	18.6	96	High transmission tempered glass with AR Tech	3.2 mm	Anodized Aluminium Alloy	IP67

Acetic (Acid)

Solar Panel Buyers Guide Refine Contact info

Reliability Survey

3. Please share information about your solar panel array (if unsure please leave blank)

Brand and Model:

Capacity (kW):

Mounting (roof, ground, etc):

4. Please share information about your solar inverter (if unsure please leave blank)

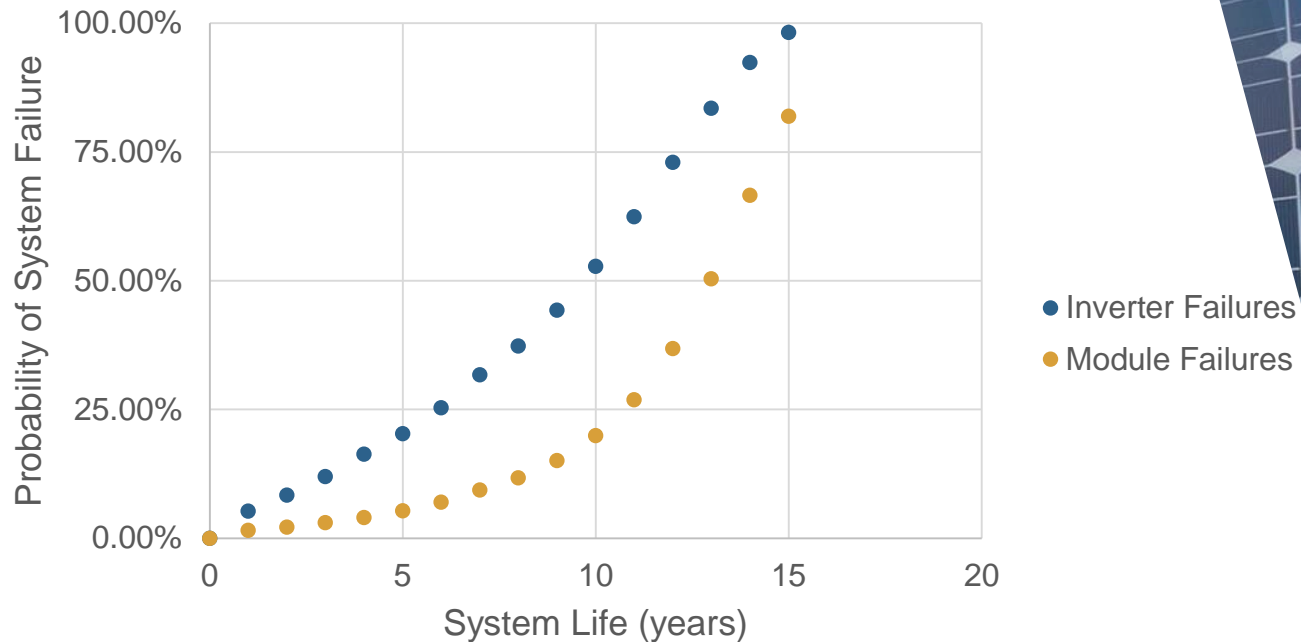
Brand and Model:

Capacity (kW):

Type (string, micro, etc):

Location (inside, outside, etc):

Methodology for Reliability Analysis



Recommendations for the **ATA**

- ▶ *Solicit consumer failure data and compile into a running database to conduct reliability analysis*
- ▶ *Request failure rate data and solar cell thickness information from solar PV manufacturers*
- ▶ *Make use of ENF Solar Database*
- ▶ *Work with Clean Energy Council to develop solar PV system shipping standards*



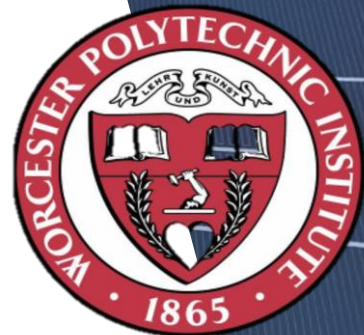
Recommendations for **Solar Consumers**

- ▶ *Hire Clean Energy Council accredited installers*
- ▶ *Solicit post-installment inspections and regular maintenance*
- ▶ *Purchase from manufacturers who conduct Electroluminescence testing*
- ▶ *Consider design, warranty, company reputation and location when purchasing a system*



Recommendations for **Future Projects**

- ▶ *Develop an educational program providing the public with the knowledge necessary to make informed solar PV system purchases*
- ▶ *Analyze the quality of off-grid system components and expanding the ATA's assessment methodology for these systems*



Thank You!

- ▶ *Everyone at the ATA for providing us with such an amazing project experience and the support we needed along the way.*
- ▶ *Solar industry professionals for providing us with the interviews and knowledge necessary to complete this project.*
- ▶ *Professors McCauley and Michalson for their dedication and guidance throughout our project.*
- ▶ *Worcester Polytechnic Institute for making it possible to experience this amazing country and work on a project that will have an effect on so many.*



Questions?

